Gun Lake

Barry and Allegan Counties, 2N/11W/1; 3N/11W/36; 2N/10W/4-6,8,9; 3N/10W/19,28-33
Kalamazoo Watershed, Surveyed April-May 2015

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Environment

Gun Lake is located 2 miles north of Orangeville between Grand Rapids and Kalamazoo in Yankee Springs and Orangeville Townships in Barry County, and in Wayland and Martin townships Allegan County. It is 2,680 acres in size, with a maximum depth of 68 feet. It has 17.8 miles of shoreline with an additional 1.4 miles of shoreline in islands. The lake has eight inlets, including those from Payne, Long, Hall, and Fawn lakes. The Hall Lake inlet feeds three walleye rearing ponds on the east shore of the lake. The outlet of Gun Lake is the Gun River, a designated trout stream for most of its length. Prior to alteration in 1892, the water level of Gun Lake water level was controlled by a large wetland draining into the Kalamazoo River. Channel dredging and wetland filling resulted in increased drainage which lowered lake levels. A stone dam was built in 1905 to regulate the lake level. In 1921, a Circuit Court Order set the Gun Lake water level at 744.32 feet above sea level and a new concrete dam was built on the Gun River. The dam was subsequently widened to the current 72 foot wide structure in 1951 due to issues of high flows causing scour below the spillway. As of this report, dam repair is being discussed as the current structure is experiencing some degradation.

Gun Lake is located in the Southern Michigan - Northern Indiana Drift Plain ecoregion. The watershed to Gun Lake has a drainage area of 21,903 acres and is located in the Kalamazoo River Basin, draining into Lake Michigan. The land use in the watershed is 31% agricultural followed by 27% forested, 16% water (12% of which is Gun Lake itself) and 13% wetland. The soils adjacent to the lake to the west are primarily sandy loams and loamy sands, which tend to be poorly drained, and have slow surface runoff. On the east side of the lake, the adjacent soils are sands or loamy sands, with some areas where cutting and filling have altered natural soils. To the west, the balance of the watershed is primarily fine sand and sand complexes. The land is nearly level or slightly undulating, and well to excessively drained. Runoff varies with the degree of slope, which can reach 40% or more. To the east, the topography is more varied, with sands, loamy sands, and muck soils scattered throughout the watershed. Drainage varies from poor in the Houghton and Adrian muck soils to well to excessively drained in the Coloma, Boyer, and Spinks loamy sand complexes.

The lake is separated into an east and west basin which differ significantly in depth and structure. The west basin is almost all uniformly shallow and has a maximum depth of less than 10 feet, with the exception of Robbin's Bay and Pickerel Cove, which have maximum depths of 34 and 25 feet, respectively. The bottom is marl with sandy shorelines. The two deeper bays have muck and marl bottoms and limited areas of gravel in the shallows. The shoreline of this basin was historically wooded, with numerous deadheads, and large areas of submerged and emergent vegetation. Depths in the east basin vary greatly, to a maximum of 68 feet. More gravel sediment is found in the east basin, and the shoreline is steeper in many areas. Historically both emergent and submergent vegetation were more limited, and fewer deadheads were present. Numerous submerged and emergent islands are surrounded by gravel bars and boulders. This basin was developed earlier and has many bulkheads and seawalls along the shoreline. Several peninsulas project into the east basin, with steep banks. There

are some shallower bays in this basin, with maximum depths of 7 to 8 feet, with sand and gravel along their shorelines.

The lake is a popular vacation and resort destination, and development has altered much of the shoreline. Gun Lake is located adjacent to the Yankee Springs Recreation Area which provides public access to the lake through a boat ramp and shore fishing opportunities. In addition, there is a County Park pay ramp on the south west shore of the west basin of Gun Lake that provides boat access. Gun Lake historically supported wild rice in shallow flats and along the shore. Alteration of shoreline due to seawall construction and increased wave action due to boating has degraded these habitats. In addition, Eurasian Milfoil has become established in areas of the lake. Weed treatments have been performed on the lake in an effort to control milfoil resulting in further reduction of vegetation. Wild rice rehabilitation on Gun Lake has been discussed by the DNR, Gun Lake Tribe, Barry Conservation District, and Gun Lake Protective Association, but programs have not proceeded due to these limitations in establishing new plants. Lack of vegetation and access to shoreline wetlands limit natural reproduction for some fish species, including Yellow Perch, Northern Pike, and Muskellunge.

History

The earliest survey on record was conducted in 1890 and noted an abundance of Yellow Perch, Bluegill, Largemouth and Smallmouth Bass. Gar and Ciscoes also were observed. At this time Walleye, White Bass and American Eels stocking was recommended. Surveys conducted in 1950 and 1952 indicated that Northern Pike, Yellow Perch, Walleye, Smallmouth Bass, Largemouth Bass, Bluegill, and Rock Bass were common throughout the lake. In addition they sampled numerous prey fish including White Sucker, Bluntnose Minnow, Banded Killifish, Logperch, Johnny Darter, Brook Silverside, and shiners (Blacknose, Mimic, Sand, Spottail, Golden, and Spotfin). Information recorded by conservation officers during 1954-1964 suggests that harvest was greatest for Bluegill and Yellow Perch. Other fish commonly harvested include Largemouth Bass, Smallmouth Bass, Pumpkinseed, Rock Bass, Crappie, and only a few Walleye.

The history of stocking in Gun Lake began when Atlantic Salmon were stocked in 1873 and 1874 and American Eel were stocked in 1881. Regular stocking has occurred since 1921 when Yellow Perch, Bluegill, and Walleye were stocked into the lake (Table 1). Three one-acre rearing ponds were constructed in 1925 by damming a small creek flowing from Hall Lake into Gun Lake and have been operated by the Gun Lake Protective Association (GLPA) from 1925 through the present. These ponds are the main contributor to the long term stocking history of the lake. Yellow Perch were stocked heavily from 1921 through 1926 when stocking numbers were reduced, and stocking became more sporadic until discontinued in 1939. Largemouth Bass, Smallmouth Bass, and Bluegill were commonly stocked from 1921 through 1954. Northern strain Muskellunge were briefly stocked in 1957 and 1961 - 1963 and again in 1977 - 1983. Initial plantings of Walleye occurred in 1921 through 1925. Walleye were not stocked again until 1973, and have been the focus of stocking efforts in Gun Lake to this date. Through a cooperative arrangement established with the DNR in 1973, the Gun Lake rearing ponds are supplied with fertilizer and are stocked with 50,000 Walleye fry per pond (total of 150,000 fry) annually in April. These fish are raised for 5 weeks (average of 33 to 35 days) and then stocked into the lake at a size of 1-1.5 inches. The rearing ponds have produced an average of 54,726 fish per year from 1973 to 2016 and numbers have increased in recent years with an average of

80,115 fish per year from 2011 to 2016. Pond production results in an average of 29.9 fish per acre being stocked into Gun Lake. In addition, private plantings of fall fingerling Walleye have occurred periodically since 2010 at a maximum rate of 2000 fish in a year or 0.8 fish per acre.

Creel data were collected in October 1985 to March 1986 to evaluate the fishery following the cessation of Muskellunge stocking. In the fall, open water fishery, anglers most commonly reported targeting any species (24%), followed by Muskellunge (18%), Walleye, Yellow Perch, and Bass (15% each) and finally Bluegill (12%). Despite the high fishing effort for Muskellunge, only one was observed in the open water creel, although no data exists for fish that were caught and released. More recent creels were conducted in 2006 and 2013 utilizing a roving type survey where interviews and counts of shore and boat anglers were conducted by boat. Anglers were also encouraged to report any tagged fish (see methods below) using the electronic tagged fish reporting system on the DNR website http://www.michigandnr.com/taggedfish/tags. Creel surveys were conducted from April - September (May - Sept for 2014) and did not include winter ice fisheries (Smith and Gunderman 2017; Zu and Smith 2006). Overall catch rate (number of fish per hour) was lower for anglers in 2014 than in 2006 (Table 2). In addition, the total number of fish caught and angler hours spent fishing were much lower in 2014 than in 2006. Bluegill was the most common species caught and had the highest catch rate in both creel surveys (Table 3). Catch rate and number of fish caught decreased from 2006 to 2014 for Northern Pike, Yellow Perch, Bluegill, Rock Bass and Black Crappie. Walleye catch rates increased significantly from 2006 to 2014 from 0.0004 fish per hour in 2006 to 0.01 fish per hour in 2014 as total catch increased from 31 fish to 501 fish. Despite the increase in catch rate, the number of Walleye caught per hour was low compared to typical catch rates in large lakes (range of 0.07 to 0.45 fish per hour; Hanchin In Press). Walleye and Black Crappie were commonly harvested when captured while catch and release was practiced for Largemouth Bass, Smallmouth Bass, Northern Pike and Rock Bass. The 2006 creel reported 103 Muskellunge caught and released while no Muskellunge were observed in the 2013 creel. Estimated numbers of released fish rely on accurate reporting from anglers for number and species captured as these fish are not observed by creel clerks. Thus, it is possible that some or all of the "Muskellunge" from the 2006 creel survey were misidentified Northern Pike. Catch rates varied between the two basins depending upon the time of year. Anglers spent more time fishing in the east basin (27,834) than the west basin (19,878), but catch rates were higher in the west basin (Figure 2). Total catch per hour decreased in both basins from May to June and increased in the west basin in the September, which was the month with the lowest overall fishing effort. Mean total catch per hour was over three times greater for Walleye in the east basin (0.014) than the west basin (0.004) and two times greater for Black Crappie. Bluegill and Pumpkinseed catch rates were over twice as high in the west basin. Catch rates were similar between the two basins for all other species reported in the creel (e.g., Largemouth Bass, Smallmouth Bass, and Northern Pike).

An additional survey was conducted in the fall of 2013 to obtain population estimates for Largemouth Bass (Smith and Gunderman 2017). A total of 148 electrofishing transects (62.8 hours) were conducted in October 2013 and all Largemouth and Smallmouth Bass were given individually numbered jaw tags. A total of 2,757 fish were caught and tagged, and 211 fish were recaptured. Population estimates for Largemouth bass were 7,398 (SE 817; 95% CI 6,026-9,309) in the east basin and 7,587 (SE 663; 95% CI 6,439-9,078) in the west basin. Largemouth Bass size structure (based on length) remained comparable to other bass populations in southwest Michigan. Population estimates for Smallmouth Bass were also similar to four comparable lakes in southwestern Michigan (see Smith and Gunderman 2017), but a decline in size structure was observed in 2013 compared to previous creel

and surveys. Black Crappie and Largemouth Bass populations were reported as significant contributors to both recreational and tournament angling in the lake. Yellow Perch populations remained sustainable and a large year class was identified in 2013, but it was hypothesized that angling pressure reduced the number of large fish. Northern Pike size structure was skewed toward sub-legal fish with few fish over 24 inches. In addition, Smith (2013) identified the decline in Muskellunge populations to below detectable levels and proposed the potential for stocking to support the fishery.

Great Lakes strain Muskellunge are native to Gun Lake and historically were sustained by natural reproduction in low numbers. There were many reports of large Muskellunge caught in Gun Lake prior to stocking with fish up to 45 lbs taken through the ice by spearing in 1933-1965. Stocking of northern strain Muskellunge was conducted in 1957 and 1961-1963 and again from 1977-1983 to supplement the population and enhance the fishery. There was also discussion of using Gun Lake as a Muskellunge broodstock lake in the 1980s. Stocking was discontinued due to angler reports of reduced numbers of Yellow Perch and lack of public support for the stockings. Surveys were conducted in 1983 to 1989 to assess the potential impact of Muskellunge on other fish in Gun Lake and prompted the initial Gun Lake Status of the Fishery Report (Duffy 1991). Despite angler reports, Yellow Perch catch and size structure did not change in surveys conducted following the Muskellunge stocking. Natural recruitment of Muskellunge continued to support a small fishery in Gun Lake although recruitment was greatly limited by the extensive development along the lakeshore. Creel data from 1985 indicated that other than those reporting they were targeting all species, the largest proportion of anglers were targeting Muskellunge. The DNR evaluated the potential for Muskellunge stocking and proposed to stock at a rate of 2/acre (5,360 fish) every other year beginning in 2013. Opposition to the stocking prompted public meetings to be held to discuss the potential of Muskellunge stocking in Gun Lake with the public and opinions were mixed. There was support for the Muskellunge stocking from angler groups, but opposition and concern from the GLPA. The GLPA conducted a survey of riparians in 2014 which resulted in 723 votes (85.5%) against planting muskies in Gun Lake, 112 (13.2%) in favor, and 11 (1.3%) undecided. The decision was made to postpone the stockings until Fisheries Division could conduct a thorough survey to determine if stocking was appropriate.

Current Status

Two surveys were conducted in 2015 to assess the status of the Gun Lake fish community. In April, netting and electrofishing efforts were utilized to evaluate Yellow Perch, Walleye, Northern Pike, and Muskellunge populations. A total of 24 trap nets and six large mesh fyke nets were set for three net nights (April 6 through April 9) for a total of 72 and 18 net nights respectively. Thirty-one electrofishing transects were conducted during the following week (April 13 through April 16). Transects were 0.5 miles long and effort averaged 1,436 seconds (23.9 minutes). All fish caught were identified, counted, and measured for length. All Walleye were given a dorsal fin spine clip for age identification and to mark the fish for mark-recapture estimates. In addition, a sub-sample of Walleye were given individually numbered jaw tags for future identification of recaptures. Only Walleye over ten inches were tagged as this is the minimum size that is fully recruited to these gear types.

Additional sampling was conducted in May using the methods for MDNR large lake Status and Trend Surveys (Wehrly et al. In Revision). Fish surveys were conducted from May 11 through May 15, 2015. The survey consisted of 12 net nights of experimental gill nets, 6 electrofishing transects of 10

minutes each, 18 net nights of large mesh fyke nets, 6 seine hauls, and 8 net nights of small mesh fyke nets. All fish were identified, counted, measured for length, and aging structures were collected for all sportfish. During the April and May surveys, weights for all fish species were calculated using the length-weight regression equations compiled by Schneider et al. (2000a). Growth was evaluated using growth index scores. Growth index is calculated as the sum of the difference in mean size for each age class (Schneider et al. 2000b).

Limnology and shoreline surveys were performed on August 11, 2015. The Secchi depth was 10 ft with light penetrating to a depth of 20 feet. The water was slightly alkaline with a pH ranging from 8.72 at the surface of the lake to 7.67 at the bottom. Surface temperature was 78 degrees F and the thermocline was between 20 and 34 feet. Dissolved oxygen dropped below 3 ppm at 24 feet and water below this depth was not suitable for fish. Temperature loggers also were deployed in the summers of 2014 and 2015 at a depth of 2.5 feet and maximum temperature never exceeded 70 degrees F (Figure 3). Shoreline development surveys were conducted along the main lake for a total of 88 transects that surveyed 1000ft of shoreline each. Channels and islands also were surveyed, but are not part of the standard protocol and will be evaluated separately. The number of docks (large and small), dwellings, submerged trees and the percent of the shoreline that is armored (riprap or seawalls) were recorded for each transect. There were a total of 995 docks and 888 houses counted along the shoreline of Gun Lake for an average of 1.3 docks and 1 house per 100 ft. of shoreline. A total of 16 transects were along the shoreline of Yankee Springs State Park which had no dwellings or docks, thus reducing the lake wide average. An average of 64% of the shoreline was armored and that percentage rose to 75% when the state park shoreline was excluded. Shoreline development was similar between basins with a slightly higher number of docks in the west basin (12.2/1000ft of shoreline) than the east basin (9.5/1000ft of shoreline), but a similar number of houses in the west and east basin (9.8 and 9.0 /1000ft of shoreline respectively). In addition, the west basin has a series of heavily developed canals on the northwest and southern shoreline. Twenty four transects were conducted within these canals and there were an average of 1.3 docks and 1.0 houses per 100ft of shoreline. Islands had almost no development with only one house and dock in the 8 transects surveyed. There was an average of 0.4 submerged trees per 100 foot of shoreline on Gun Lake. The density of trees was highest on the islands (1.1/100ft) and lowest in the canals (0.2/100ft) and the main lake averaged 0.32 trees/100ft of shoreline

Whereas the April survey targeted specific game species during spawning season, the intent of the May 2015 sampling was to evaluate the overall fish community in the lake. A total of 12,451 fish were collected during the May 2015 survey with a combined biomass of 666.3 pounds (Table 4). Shiners and Bluntnose Minnows were abundant. Large-bodied forage fish (e.g., White Suckers) were rare. Panfish (Bluegill, Black Crappie, Pumpkinseed, Rock Bass, Warmouth, Yellow Perch, and hybrid sunfish) composed 27% of the total biomass, whereas carp and bullheads made up 20%. The primary predators collected were Northern Pike, Walleye, Largemouth Bass, Smallmouth Bass, Longnose Gar, and Bowfin. Predators made up 44% of the total biomass in Gun Lake (48% of non-common carp biomass) which is close to the maximum recommended proportion of 50% (20-50% is considered balanced; Schneider 2000; Schneider and Crowe 1980; Schneider 1981).

Bluegill was the most abundant species caught other than minnows and shiners. A total of 1,854 Bluegill were collected and ranged from 1 to 9 inches and made up 4.7% of the biomass in the April survey and 10% of the biomass in the May survey. Bluegill growth was within the average range for

Michigan lakes (mean growth index = -0.3; Figure 5). Mean length of Bluegill captured was 4.5 inches and Bluegill greater than 6 inches made up 19% of the catch, over 7 inches made up 5% and over 8 inches made up 1.2% of the total catch of Bluegill. These size structure metrics result in a Bluegill population rated as "Acceptable" using a population index developed for Bluegill in Michigan waters (Schneider 1990). Large Bluegills were present in Gun Lake with multiple Master Angler submissions over 10 inches and a 10.5 inch fish submitted in 2014. There are also good numbers of Pumpkinseeds and Rock Bass in Gun Lake, and growth index was above average at 1.1 for Pumpkinseed. Pumpkinseeds reached age 7 and a maximum size of 8.4 inches. Multiple Master Angler Pumpkinseed have been submitted for Gun Lake with many 9 inch fish and one 10 inch fish caught in 2014.

A total of 195 Yellow Perch were collected in April and May surveys on Gun Lake. Length ranged from 2-12 inches with more large fish being captured in the April survey. Mean length at age for Yellow Perch was below the state average for age-3 fish, but similar to averages for older fish (Figure 4). Growth index was -1.1 for yellow perch in the May survey but was slightly above average at 0.5 in the April Survey and 0.7 in the 2013 survey.

Largemouth bass was the most abundant predator in Gun Lake. A total of 418 Largemouth Bass were collected in 2015 surveys. Growth was average with an index score of 0. Largemouth bass up to age 11 were captured with the largest being 19.5 inches. Two Master Angler Largemouth Bass have been submitted for Gun Lake in 2011 and 2012 that were 22.0 and 22.5 inches respectively. Smallmouth Bass numbers were much lower with only 19 being captured. Growth could not be estimated due to the low number of fish caught, but the largest Smallmouth Bass observed was 18 inches in length.

Surveys in April of 2015 were utilized to assess Walleye populations. A total of 214 Walleye were captured across all gear types (Table 5). Jaw tags were given to 111 Walleye and a total of 16 of the tagged fish were recaptured in April and May samples. Schumacher-Eschmeyer mark recapture estimates for multiple surveys with continued marking were utilized to estimate walleye populations (Ricker 1975). The estimated number of Walleye in Gun Lake was 957 fish (0.36 fish per acre) with a 95% confidence range from 574 to 1621 fish, which is lower than the average population estimate of 2 fish per acre observed during large lake surveys in northern Michigan (Hanchin In Press). In addition to population estimates, we evaluated Walleye populations by comparing catch rates from various gears to other large lakes in Michigan. Walleye catch rates were 2.7 fish per hour of electrofishing, 2.0 per trap net night, and 2.0 per fyke net night (Table 6). Catch rates were below average when compared to catch rates from surveys in 22 large lakes (> 1700 acre) in northern Michigan from 2002 through 2011 (Hanchin; In Press). Catch rates for Walleye varied by basin. CPE was higher in the east basin than the west basin for electrofishing (east: 3.2 fish per hour; west: 1.7 fish per hour) and fyke nets (east: 2.8 fish per net night; west: 0.7 fish per net night). Trap net catch rates were similar between the east and west basins with CPE of 2 and 2.1 per net night respectively. Walleye length at age was greater than the state average for fish age-1 to age-7 (Figure 5). Growth index was also higher than the state average with a value of + 1.5 (Table 7). Catch at age data were used to calculate mortality rate for Walleye using the number of fish sampled in each age class assuming mortality was constant across age class and years. Mortality estimates from electrofishing surveys varied from 0.13 in 2013 surveys to 0.39 in 2015 surveys. Estimates of mortality from trap net data from 2015, which only include year classes prior to 2012 was 0.25 and similar to the mean of 2013 and 2015

electrofishing estimates of 0.26. These estimates of mortality indicate that a quarter of the standing stock of Walleye is lost each year to a combination of fishing and natural mortality.

Gun Lake is typically stocked with spring fingerling Walleye from the rearing ponds. Fall fingerling Walleye are purchased privately and periodically stocked in fall. These fish are larger and more expensive than spring fingerlings, but may have advantages in growth or survival. Stocking strategy for Walleye was evaluated to compare catch rates of fish that were stocked as spring fingerlings produced in rearing ponds to the fall fingerlings. A subsample of Walleye was aged to evaluate growth from each survey. Because efficiency of sampling gears varies by age (e.g. trap nets more efficient in catching larger fish), estimates were made for each gear type. Length-to-age keys were developed from the aged Walleye in each survey by gear type and were used to assign each fish captured to an age class. Stocking year was determined from the age of each fish and catch per effort was calculated to standardize between efforts. The regression line of catch per effort through time was used to estimate average predicted catch and the deviation from that line (residuals) indicated if a stocking year class exhibited above or below average catch rates. Because the fish were not marked by stocking type, we assessed trends in years where only one type of stocking was performed compared to years where both occurred. We evaluated stockings from 2010 through 2014 as these were the age classes represented well in the 2013 and 2015 surveys. Only fall fingerlings were stocked in 2010 and both spring and fall fingerlings were stocked in 2011, 2012, 2013, and 2014. All year classes from 2010 to 2014 stockings were captured in the lake surveys indicating each year class contributed to the fishery. Year class strength tended to alternate from year to year from high to low CPE of Walleye (Figure 6). The 2012 year class had below average contribution to the observed catch despite stocking high numbers of both spring (n = 125,042) and fall (n = 2000) fingerlings. The 2014 stocking was composed of only 1000 fall fingerlings, and a reduced number of rearing pond fish, but still contributed to the fishery, although in numbers below the average contribution. We observed variation in catch rate of stocked fish through time, but the variation did not appear to relate to the number of fish stocked or the type of stocking. It is clear that both spring and fall fingerlings are contributing to the fishery, even when stocked in low numbers.

Northern Pike and Muskellunge populations were also evaluated using April 2015 catch data. No Muskellunge were caught in 2015 surveys. A total of 227 Northern Pike were captured across all gear types and ranged from 10 to 35 inches (Table 5). Catch rates were 1.6 fish per hour of electrofishing, 2.0 per trap net night and 2.0 per fyke net night. Catch rates for Northern Pike were similar to average catch rates from surveys in 22 large lakes (> 1700 acre) throughout Michigan from 2002-2011 (Hanchin In Press). Data from the April and May sampling efforts were combined to evaluate Northern Pike growth rates. Mean length of Northern Pike in Gun Lake was slightly above average at age-1, but dropped to slightly below state average from age-2 through age-5 (Figure 7). The mean growth index was -0.34, which is within the satisfactory range (Table 7). The Gun Lake growth index was lower than the mean index score of +0.5 for other large lakes (Hanchin In Press) and low compared to other lakes in the SLMMU where growth index scores are generally above 0.

Common Carp populations have been a perceived problem in Gun Lake by anglers and riparians (lakefront and home owners). We only collected 11 Common carp in the 2015 surveys, but they made up 8% of the total biomass caught in May. The Longnose Gar catch was low (n = 6) compared to past surveys. Yellow and Brown Bullhead were captured in average numbers in April and May surveys

and ranged from 7-15 inches. Despite the high numbers in the lake, bullheads were rarely represented in creel surveys with only 78 caught of which 28 were harvested in 2006 and 2014 combined.

Analysis and Discussion

Shoreline development resulting in limited littoral habitat continues to be the largest limitation to fish communities on Gun Lake. High percentages of armored shoreline and lack of woody cover and submerged trees greatly limits the inshore fish habitat (Schindler et al. 2000). Lack of these habitats limits recruitment, survival and growth of fish species dependent on inshore cover. Vegetative cover is also scarce in much of Gun Lake. Issues with invasive vegetation such as Eurasian Milfoil have resulted in herbicide vegetation treatments in Gun Lake. Although these treatments attempt to target noxious vegetation, they also can damage the natural vegetation in the lake resulting in reduced cover. In addition, weed treatments are used by some riparians to eliminate all vegetation to improve beaches and boat access to docks. Boat traffic is heavy on the lake and vegetation is also subject to limitation by wave action.

Bluegill catch rates have increased in surveys since 1960, but size structure has shifted smaller with few fish over 8 inches (Table 8). Increased numbers and decreased growth could be an early indication of stunting; however bluegill populations are still rated as acceptable. Size structure has shifted through time, but has not decreased significantly, although the mode of catch occurred at a smaller size in 2015 than in previous surveys (Figure 8). Creel catch data also shows that 75 percent of Bluegill caught are released potentially because they are too small and not desirable for harvest. Despite increases in density, CPE from electrofishing was 2.6 fish per minute which is in the lower 25% of 25 status and trend lakes sampled in 2002 to 2007 (median CPE = 4.9 fish per minute). CPE from fyke nets (23.9 fish/net night) was also lower than the median from the same 25 lakes (35.2 fish/ net night). This would suggest that densities are low compared to other lakes in the Southern Lake Michigan Management Unit, although density dependent mechanisms (e.g. prey availability) can vary by lake. Changes in growth and density did not coincide with Muskellunge stocking as numbers continued to increase after Muskellunge were no longer abundant in Gun Lake. Predator stocking can be a strategy to manage overabundant Bluegill populations as it reduces competition for resources by thinning the number of small Bluegill resulting in increased growth rates (Schneider 1995; Schneider and Lockwood 1997). As Walleye stockings become more consistent, they should continue to provide adequate predation to prevent overabundance and stunting in Bluegill populations.

Largemouth Bass are the most abundant predator in Gun Lake. Population estimates from 2013 surveys indicate that their population density is average for lakes in the region. Catch rates from electrofishing surveys have increased from 1983 through 2015. Growth rates were also average in 2015, but were considered low in 2013 surveys (-1.3). Growth index has fluctuated around average since 1961 and the fishery is considered satisfactory. Minnow and sunfish (e.g., Bluegill, Black Crappie, and Pumpkinseed) prey are abundant in Gun Lake and growth rates have been acceptable for Largemouth Bass. Smallmouth Bass numbers have always been lower than Largemouth Bass in Gun Lake. Despite low densities, Smallmouth Bass are still captured in the creel and are providing a limited fishery. Gun Lake is also a popular bass tournament lake and in 2016, 25 bass tournaments were held out of the Yankee Springs Recreation Area boat launch and 8 were held out of the Gun Lake County Park launch.

Low density of wood and vegetative habitat results in limited habitat for a number of fish species especially Largemouth Bass, Bluegill, Northern Pike and Muskellunge. Wood densities are low as a result of heavy shoreline development resulting in clearing of trees along the shoreline preventing new downfalls and the removal of fallen trees from the water by riparians. It is evident that Gun Lake has a very high level of shoreline disturbance resulting in degraded shoreline habitat. Both Bluegill and Largemouth Bass growth rates and the production capacity of aquatic ecosystems can be reduced in lakes with highly developed shorelines (Schindler et al. 2000). Shoreline development is related to increased angling pressure, decreased water quality, and decreased woody habitat. Both Largemouth Bass and Bluegill production decreases when vegetation is absent or densities are too low (Wiley et al. 1984; Savino at al. 1992). Largemouth Bass recruitment has also been shown to decline when vegetation coverage is low (Durocher et al 1984; Miranda and Pugh. 1997). Vegetation and woody habitat increases survival of young-of-year Largemouth Bass by providing refuge from predation and access to quality prey. Growth rates of Largemouth Bass and Bluegill could be improved in Gun Lake with habitat restoration efforts and best management practices. Establishing vegetation, reducing herbicide treatments that affect native vegetation, wood additions, preventing wood removals, softening banks, and removing armoring could all result in benefits to the fish community. Habitat restoration on a lake wide scale is unreasonable, but taking advantages of opportunities for habitat restoration can result in local or cumulative benefits to Gun Lake.

Yellow Perch support one of the larger fisheries in Gun Lake. Their populations are maintained by natural recruitment and the population has not changed dramatically through time. Maximum size of perch ranged from 10-12 inches in early surveys and fish up to 12 inches were observed in the spring 2015 surveys. Growth rates have fluctuated slightly around average (-0.5 to +0.8) and mean growth indices have been above 0 in surveys since 1989. Size structure is currently better than in the past with 12% of the fish above 10 inches in the 2010 to 2015 surveys. Walleye have been shown to prey heavily on small Yellow Perch thus reducing densities and enhancing growth rates (Schneider 1969, Schneider 1995; Laarman 1978). Walleye predation can improve the Yellow Perch population if young-of-year production is high, but if recruitment is low, it can reduce the density of Yellow Perch to the point of impacting the fishery. Populations should be monitored as consistent Walleye stocking could result in increased levels of predation on Yellow Perch.

Walleye catch rates were below average when compared to other large lakes in the state of Michigan. Catch rates were higher in the east basin than in the west basin of Gun Lake. In April netting and electrofishing surveys, Walleye were targeted while spawning. Spawning habitat is better in the east basin than the west as it has closer proximity to deep water and more gravel and rocky substrate. Catch rates for Walleye were also higher in the creel for the east basin throughout the year. The catch rates in the east basin were still lower than the state average. Growth rates were above average indicating that there is plenty of forage for Walleye. Growth rates for Walleye have always been high in Gun Lake and growth index scores average +2.3 and have never been below average in any survey with adequate age data.

Walleye population densities are generally lower in southern Michigan lakes than in northern Michigan lakes. Walleye spawning habitat is more common in northern Michigan lakes resulting in populations that are supported partially or entirely by natural reproduction. Summer water temperatures in northern Michigan lakes also tend to favor Walleye over Largemouth Bass, whereas

the reverse situation occurs in southern Michigan lakes. The number of older fish in the 2015 sampling was influenced by the stocking history in the lake. Spring fingerling stocking was discontinued during 2007-2010 because the discovery of viral hemorrhagic septicemia (VHS) in the Great Lakes disrupted the supply of hatchery fish. Numbers of larger fish are expected to increase as stocking rates have been more consistent and older age classes will become better represented through time. Walleye populations are unlikely to be maintained by natural recruitment in Gun Lake. Natural reproduction is occurring as a small number of fish were captured from year classes where stocking did not occur, however they only contribute to the fishery in very low numbers.

Stocking strategies for Walleye usually implement an every other or every third year stocking because the age-1 year class can limit the survival of newly stocked fish (Laarman 1978; Schneider 1969). We do see some indication of stocked Walleye suppressing success of consecutive years of stocking in Gun Lake. Ideally, we would stock 134,000 spring fingerling Walleye (50 fish/acre) in Gun Lake on an every other year schedule. However, it is not feasible to produce 134,000 spring fingerling Walleyes in the Gun Lake rearing ponds in any given year. Thus, logistical realities necessitate every year stocking with lower stocking densities.

Gun Lake supports a popular fishery for Walleye and catch and harvest numbers were up in the 2014 creel survey when compared to 2006. As previously noted, comparisons to other large lakes in more northern latitudes in Michigan must be interpreted with caution. Walleye fishing opportunities are limited in southwest Michigan and Gun Lake provides one of the premiere Walleye fisheries for this part of the state and is one of the largest lakes in the area.

Comments in the creel survey indicated anglers believed that Northern Pike catch rates have been declining. MDNR survey data indicates that the population density is actually increasing. High numbers of Northern Pike were captured in the most recent surveys, and catch rates were comparable with other large lakes in Michigan. Northern Pike catch rates have increased in electrofishing, gill net, and trap net surveys since the 1983 survey. The increase in Northern Pike numbers coincided with the cessation of Muskellunge stocking. Northern Pike may be replacing a declining Muskellunge population as prey and habitat become more available. Catch rates of Northern Pike are well above that of historic surveys where only a few fish were caught. Northern Pike growth indices were below 0, but still in the acceptable target range. Growth rates were similar to those in a 1989 survey which is the only other survey with enough fish aged to calculate growth index values. Generally, larger lakes in Michigan and lakes in the southwestern part of the state have above average growth rates. In comparison, growth rates of Northern Pike in Gun Lake are low although still considered acceptable. Density dependent mechanisms (such as competition for food) can reduce Northern Pike growth when their densities are high (Margenau et al. 1998; Pierce et al. 2003).

White Suckers are a preferred prey species of large Northern Pike and recent surveys indicate that they are present, but not abundant in Gun Lake. Historically, White Suckers were collected in greater numbers when Northern Pike populations were low. White Sucker populations could be suppressed by Northern Pike predation; however recruitment may also be limited. White Suckers run into feeder streams to spawn and access to these streams is often impacted in areas of high development. Poor quality road crossings and dams can block White Sucker migrations resulting in poor recruitment and reduced populations. Some recent restoration work on Gun Lake tributaries (e.g. Cuddy Drain) has resulted in White Suckers regaining access to traditional spawning streams and future efforts should

consider fish passage in order to promote access to essential habitat. Despite low density White Sucker populations, Northern Pike are still exhibiting acceptable growth and are probably utilizing other sources of prey such as minnows, Yellow Perch, and sunfish. Northern Pike populations should be monitored for signs of stunting especially if densities continue to increase.

Muskellunge were not captured in recent surveys in Gun Lake. They were reported in the 2006 creel as fish caught and released by anglers, but the last Muskellunge collected by the MDNR was in 1999 surveys. Low density Muskellunge populations historically were supported by natural reproduction, but the population has decreased following the cessation of stocking and natural recruitment is no longer maintaining a viable population. Natural recruitment of Muskellunge has been impacted by loss of spawning and rearing habitat (Axon and Kornman 1986; Rust et al. 2002; Kapuscinski et al. 2007; Cooper et al. 2008). Altered shoreline, high wave action, and weed treatments have degraded these habitats in Gun Lake and contribute to the lack of recruitment of Muskellunge. If a Muskellunge fishery is to continue in Gun Lake, it will require stocking to maintain the population. In the future, habitat restoration efforts could help increase natural recruitment of Muskellunge reducing the need for stocking.

Reintroduction of Muskellunge to waters where they have been extirpated or reduced was identified as a major restoration goal for the species in their native range (Crane et al 2015) and rehabilitation has been established as a goal in Michigan (Dexter and Neal 2004; Smith et al. 2016). Accordingly, stocking of Muskellunge should at least be considered in Gun Lake. Muskellunge have been shown to prey primarily on White Suckers and Yellow Perch when available (Bozek et al. 1999). White Suckers are not abundant in Gun Lake resulting in the potential for heavy predation on Yellow Perch. However, evaluations of previous Muskellunge stockings in Gun Lake revealed no changes in abundance or size structure for any fish species throughout the time period Muskellunge stocking was occurring. In fact, Yellow Perch catch rates in gill and trap net surveys peaked in 1989 and increased in electrofishing surveys from 1983 to 1999 when abundances of stocked Muskellunge of predatory size were at the highest. Walleye stocking survival can be negatively influenced by abundant Largemouth Bass populations (Santucci and Wahl 1993; Nate et al. 2003; and Inskip and Magnuson 1983; Fayram et al. 2005), but has not been linked to Muskellunge populations (Fayram et al. 2005). In an evaluation of 41 lakes stocked with Muskellunge in Minnesota, no negative trends in catch rates of other sportfish were observed (Knapp et al. 2008). Although some predation of Yellow Perch will occur, it is doubtful that Muskellunge stocking would noticeably impact the fishery for Yellow Perch and other sport fish in Gun Lake, especially if introduced in reduced numbers. In addition, stocked Muskellunge should readily prey on rough fish (e.g., Common Carp) and could help control their populations in Gun Lake.

Another concern when considering Muskellunge stocking is if stocking efforts could maintain a minimal population in Gun Lake. Muskellunge stocking success may be limited by the increasing numbers of Northern Pike in Gun Lake. Muskellunge stocking success and recruitment can be limited by predator populations (Szendrey and Wahl. 1996; Wahl 1999), in particular Northern Pike (Inskip 1986; Farrell et al. 1996) through competition for resources and direct predation. Northern Pike populations have been identified as the possible cause of poor survival of stocked Muskellunge in Wisconsin lakes (Margenau 1999). Northern Pike and Muskellunge previously coexisted in Gun Lake, but Northern Pike abundance appears to have increased since the last round of Muskellunge stocking.

Any fishery involves two components: fish populations and the human users. After analyzing the 2015 survey data, Fisheries Division staff met with the GLPA board to discuss the possibility of a low level stocking of 0.5 fall fingerling Muskellunge per acre every other year. The results of the survey outlined in this report were presented to the board and an issue statement was provided to assess GLPA member opinions regarding stocking. The GLPA board presented the proposed stocking at their annual meeting in fall of 2017 and attendees voted by show of hands (one vote per household). There was a total of 79 votes, of which 51.8% opposed and 34.2% supported stocking (13.9% had no opinion). Following the meeting, a survey was sent out to the GLPA membership and a total of 434 survey responses were recorded. The results of the mail survey were 65.4% opposed, 24.9% support, and 9.7% undecided. Despite some increase in support for muskellunge stocking in Gun Lake by the GLPA membership compared to the 2014 survey, the majority continued to oppose stocking. Due to the lack of GLPA support, the existing predator-prey ratio, and limited availability of suitable spawning habitat, Muskellunge stocking is not proposed in the current management plan.

Management Direction

The overarching management goal for Gun Lake is to maintain a diverse fishery. This can be accomplished through continuing to stock Walleye and promote Largemouth Bass, Yellow Perch, and Bluegill fisheries. Efforts should be made to enhance habitat by promoting vegetation and woody habitat in the lake. In addition increased connectivity between Gun Lake and streams that feed and flow from the lake should allow fish passage and promote natural recruitment. These objectives can be accomplished utilizing the following management objectives.

Continue the cooperative effort with the Gun Lake Protective Association to rear Walleye utilizing their three lakeside rearing ponds to be stocked in Gun Lake. Continue to stock 50,000 fry annually into each of the three rearing ponds (150,000 fry total). In past years periodic, low-density stocking of fall fingerlings by the GLPA has supplemented the Walleye fishery in the lake. Such stockings should continue to be permitted. Consistent Walleye stocking should reduce the abundance of small Bluegill, potentially increasing the growth rate for Bluegill in Gun Lake.

Continue to look for potential opportunities to enhance fish habitat in Gun Lake. This can be accomplished through establishing vegetation and increasing availability of woody cover. Protecting vegetated areas from weed treatment and wave action could have positive effects on the number and growth of many fish species in the lake. Woody structure should not be removed from the lake and establishing new woody habitat could benefit a number of fish species. Softening of the shoreline should also be promoted. Removal of seawalls and development of natural shorelines should be promoted when possible (see Michigan Shoreland Stewards Program). Shoreline habitat is one of the primary factors limiting fish populations in Gun Lake.

We will continue to work with various groups involved with the repair of the Gun Lake Dam, Marsh Road crossing, and other fish passage barriers to encourage the potential for including fish passage as part of the project. Dam repair work is currently being planned and initial meetings were held to discuss dam passage. We are committed to work with interested parties to explore options. Allowing fish to pass the Gun Lake Dam has potential to increase White Sucker densities in the lake which

would provide additional forage for predatory game fish. In addition, Walleye and other game fish that may escape over the dam would be allowed to reenter the lake.

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Table 1. Fish stocking history for Gun Lake from 1921 to 2016.

Year	Walleye	Muskellunge	Largemouth Bass	Smallmouth Bass	Bluegill	Yellow Perch	Other
2016	61,421	---	---	---	---	---	---
2015	62,331	---	---	---	---	---	---
2014	39,852	---	---	---	---	---	---
	1,000i	---	---	---	---	---	---
2013	48,437	---	---	---	---	---	---
	2,000i	---	---	---	---	---	---
2012	125,042	---	---	---	---	---	---
	2,000i	---	---	---	---	---	---
2011	143,607	---	---	---	---	---	---
	2,000i	---	---	---	---	---	---
2010	2,000i	---	---	---	---	---	---
2009	---	---	---	---	---	---	---
2008	---	---	---	---	---	---	---
2007	---	---	---	---	---	---	---
2006	74,181	---	---	---	---	---	---
2005	---	---	---	---	---	---	---
2004	---	---	---	---	---	---	---
2003	---	---	---	---	---	---	144h
2002	84,328	---	---	---	---	---	---
2001	128,357	---	---	---	---	---	---
2000	---	---	---	---	---	---	---
1999	317,585	---	---	---	---	---	---
1998	134,640	---	---	---	---	---	---
1997	129,534	---	---	---	---	---	---
1996	96,528	---	---	---	---	---	---
1995	31,717	---	---	---	---	---	---
1994	---	---	---	---	---	---	---
1993	62,934	---	---	---	---	---	---
1992	10,417	---	---	---	---	---	---
1991	18,050	---	---	---	---	---	---
	300,000a	---	---	---	---	---	---
1990	53,440	---	---	---	---	---	---
1989	11,797	---	---	---	---	---	---
1988	48,392	---	---	---	---	---	---
1987	33,875	---	---	---	---	---	---
1986	20,153	---	---	---	---	---	---
1985	17,181	---	---	---	---	---	---
1984	19,368	---	---	---	---	---	---
1983	17,618	4,839	---	---	---	---	---
1982	15,636	1,742	---	---	---	---	---

Table 1. Continued

Year	Walleye	Muskellunge	Largemouth Bass	Smallmouth Bass	Bluegill	Yellow Perch	Other
1981	9,037	4,002	---	---	---	---	---
1980	9,933	2,010	---	---	---	---	---
1979	13,318	1,677	---	---	---	---	---
1978	917	---	---	---	---	---	---
1977	19143	3,000	---	---	---	---	---
1976	20,699	---	---	---	---	---	---
	600,000a	---	---	---	---	---	---
1975	31,468	---	---	---	---	---	---
	30,00,000a	---	---	---	---	---	---
1974	4,323	---	---	---	---	---	---
	1,950,000a	---	---	---	---	---	---
1973	164	---	---	---	---	---	---
1972	---	---	---	---	---	---	---
1971	---	---	---	---	---	---	---
1970	---	---	---	---	---	---	---
1969	---	---	---	---	---	---	---
1968	---	---	---	---	---	---	---
1967	---	---	---	---	---	---	---
1966	---	---	---	---	---	---	---
1965	---	---	---	---	---	---	---
1964	---	---	---	---	---	---	---
1963	---	197	---	---	---	---	---
1962	---	9,200	---	---	---	---	---
1961	---	800b	---	---	---	---	---
1960	---	---	---	---	---	---	---
1959	---	---	---	---	---	---	---
1958	---	--	---	---	---	---	---
1957	---	2,800	---	---	---	---	---
1956	---	---	---	---	---	---	---
1955	---	---	---	---	---	---	---
1954	---	---	2,000	---	6,320	---	---
1953	---	---	10,000	---	20,000	---	---
1952	---	---	---	---	23,000	---	---
1951	---	---	8,976	---	---	---	2,000d
1950	---	---	6,655	---	14,800	---	1,550d
1949	---	---	5,196	---	23,000	---	---
1948	---	---	1,960	950	26,000	---	---
1947	---	---	4,245	2,158	---	---	---

Table 1. Continued

Year	Walleye	Muskellunge	Largemouth Bass	Smallmouth Bass	Bluegill	Yellow Perch	Other
1946	---	---	---	---	---	---	56,000e
1945	---	---	14,000	---	72,000	---	---
1944	---	---	10,500	17,500	29,000c	---	---
1943	---	---	5,000	2,900	116,000	---	---
1942	---	---	6,150	600	76,600	---	---
1941	---	---	11,800	16,000	57,000	---	---
1940	---	---	4,800	1,000	43,000	---	---
1939	---	---	7,100	10,450	77,000	29,000	90,000f
1938	---	---	4,500	1,100	15,750	8,000	---
1937	---	---	9,600	5,500	25,000	---	---
1936	---	---	10,900	24,200	59,500	5,850	70,500f
1935	---	---	7,000	10,000	63,000	5,000	---
1934	---	---	10,340	---	6,500	1,600	---
1933	---	---	5,800	3,000	3,300	3,600	---
1932	---	---	2,700	4,100	14,000	---	---
1931	---	---	7,700	5,500	34,800	39,500	---
1930	---	---	7,160	4,800	14,000	4,500	---
1929	---	---	4,500	4,000	5,170	---	---
1928	---	---	4,500	5,300	2,900	---	---
1927	---	---	5,000	6,000	50,000	---	---
1926	---	---	14,000	13,750	130,000	800,000a	---
1925	150,000a	---	---	7,950	3,500	32,000	---
	---	---	---	---	---	300,000a	---
1924	---	---	2,000	2,750	3,750	600,000a	---
1923	150,000a	---	8,000	15,000	15,000	40,250	7,500g
	---	---	---	20,000a	---	1,050,000a	---
1922	160,000a	---	---	11,500	5,000	13,500	10,500g
	---	---	---	---	---	6,000c	---
	---	---	---	---	---	360,000a	---
1921	324,000a	---	---	---	3,750	40,500	---
	---	---	---	---	---	368,000a	---

a=Fry
b=Sublegal
c=Yearling
d=Rainbow Trout
e=Fathead Minnow
f=Emerald Shiner
g=Sunfish
h=Northern Pike
i=Private Plant Fall Fingerlings

Table 2. Fishing effort estimates from the 2006 and 2014 creel censuses.

2014

Effort	Catch per Hour	April	May	June	July	August	Sept	Season	Adjusted Season (No April)
Total Harvested	0.4242	NA	7,702	5,131	3,353	1,818	2,239	20,242	20,242
Total Released	1.4774	NA	17,758	14,729	16,710	11,141	10,151	70,488	70,488
Total Caught	1.9016	NA	25,460	19,860	20,063	12,958	12,390	90,730	90,730
Angler Hours		NA	8,241	13,272	12,309	8,054	5,836	47,712	47,712
Angler Trips		NA	2,438	1,867	4,017	2,555	2,097	12,975	12,975

2006

Effort	Catch per Hour	April	May	June	July	August	Sept	Season	Adjusted Season (No April)
Total Harvested	0.5971	6,753	7,907	17,856	4,469	2,969	3,682	43,636	36,883
Total Released	2.1643	14,723	22,017	50,280	34,178	23,736	13,225	158,160	143,437
Total Caught	2.7614	21,476	29,924	68,137	38,647	26,705	16,907	201,795	180,319
Angler Hours		6,157	9,174	19,987	18,359	12,768	6,632	73,077	66,920
Angler Trips		1,444	2,574	5,815	4,847	4,398	1,939	21,018	19,574

Table 3. Catch results from the 2006 and 2014 creel censuses on Gun Lake.

Species	2006			2014		
	Catch Per Hour	Total Caught	Percent Released	Catch Per Hour	Total Caught	Percent Released
Black Crappie	0.283	15588	45.5	0.0785	3747	32.3
Bluegill	1.3258	90642	75.7	0.9941	47431	74.0
Largemouth Bass	0.2744	19183	96.9	0.4042	19285	96.5
Muskellunge	0.0014	103	100.0	0	0	0.0
Northern Pike	0.086	6094	97.0	0.0573	2738	90.0
Pumpkinseed	0.0432	2643	65.4	0.071	3387	58.6
Rock bass	0.4384	28736	92.5	0.1102	5255	82.0
Smallmouth Bass	0.0634	4277	93.5	0.0601	2871	95.8
Walleye	0.0004	31	35.5	0.0105	501	17.8
Yellow Perch	0.242	12772	83.6	0.0909	4335	84.0

Table 4. Catch results from surveys conducted in May of 2015 to evaluate fish populations in Gun Lake. Fish were captured using electrofishing, experimental gill net, small mesh fyke net, large mesh fyke net, and seine gears.

May

SPP	Number	Weight (lb.)	Percent by Weight	Length Range (in)	Mean Length
Banded Killifish	44	0.3	0.0	1 - 2	2.5
Black Crappie	34	11.4	1.7	2 - 12	7.5
Blacknose Shiner	2027	7.3	1.1	1 - 3	2.4
Bluegill	831	67.3	10.1	1 - 9	4.5
Bluntnose Minnow	6322	23.0	3.4	1 - 3	2.2
Bowfin	9	40.3	6.0	19 - 26	23.2
Brook Silverside	11		0.0	2 - 3	2.9
Brown Bullhead	5	4.6	0.7	8 - 13	12.3
Central Mudminnow	1	0.0	0.0	2 - 2	2.5
Common Carp	8	54.3	8.2	5 - 30	22.0
Creek Chub	1	0.0	0.0	2 - 2	2.5
Emerald Shiner	7	0.0	0.0	3 - 3	
Golden Shiner	1	0.1	0.0	7 - 7	7.5
Hybrid Sunfish	78	20.2	3.0	4 - 8	6.8
Iowa Darter	2	0.0	0.0	1 - 1	1.5
Johnny Darter	2	0.0	0.0	1 - 2	2.0
Largemouth Bass	78	64.5	9.7	2 - 19	10.9
Logperch	101	1.0	0.2	2 - 4	3.4
Longnose Gar	6	15.5	2.3	26 - 35	30.2
Mimic Shiner	2278	12.3	1.8	1 - 3	2.6
Northern Pike	51	124.1	18.6	11 - 30	21.4
Pumpkinseed	105	30.7	4.6	3 - 8	6.9
Rock Bass	139	37.0	5.6	1 - 10	6.3
Smallmouth Bass	5	4.1	0.6	3 - 15	10.5
Walleye	21	43.1	6.5	10 - 23	17.8
Warmouth	79	21.5	3.2	3 - 9	6.7
White Sucker	1	2.9	0.4	19 - 19	19.5
Yellow Bullhead	98	74.3	11.1	8 - 14	11.6
Yellow Perch	106	6.4	1.0	2 - 8	4.8
Grand Total	12451	666.3	100.0	1 - 35	6.1

Table 5. Catch results from surveys conducted in April of 2015 to evaluate Walleye and Northern Pike populations in Gun Lake. Fish were captured using electrofishing, trap net and large mesh fyke net gear types.

April

SPP	Number	Weight (lb)	Percent by Weight	Length Range (in)	Mean Length
Black Crappie	1256	864.9	20.2	4 - 13	10.5
Bluegill	1023	200.0	4.7	3 - 9	6.2
Bowfin	155	638.2	14.9	16 - 26	22.5
Brown Bullhead	149	155.3	3.6	8 - 15	13.1
Common Carp	3	19.5	0.5	5 - 30	20.2
Golden Shiner	1	0.2	0.0	8 - 8	8.5
Grass Pickerel	1	0.4	0.0	12 - 12	12.5
Hybrid Sunfish	57	17.6	0.4	4 - 9	7.1
Lake Chubsucker	1	0.2	0.0	7 - 7	7.5
Largemouth Bass	340	444.1	10.4	8 - 18	13.4
Northern Pike	227	666.8	15.6	10 - 35	23.0
Pumpkinseed	196	73.2	1.7	4 - 9	7.4
Rock Bass	949	270.7	6.3	3 - 11	6.9
Smallmouth Bass	14	26.8	0.6	10 - 18	15.0
Spotted Gar	2	2.9	0.1	21 - 23	22.5
Walleye	214	519.6	12.1	9 - 26	18.9
Warmouth	13	5.2	0.1	4 - 9	7.7
White Sucker	6	15.1	0.4	15 - 22	18.3
Yellow Bullhead	435	328.5	7.7	7 - 15	11.6
Yellow Perch	89	28.0	0.7	6 - 12	8.8
Grand Total	5131	4277.1	100.0	3 - 35	10.4

Table 6. Catch per effort of Walleye and Northern Pike by gear type in past surveys on Gun Lake in April 2015 and on comparable large lakes throughout Michigan. Large lake survey data is from Hanchin (In Press).

Lake	County	Sampling Period	Size (Acres)	Angler Hours per Acre	Walleye		Pike	
					Trap-net CPE (#/net night)	Fyke-net CPE (#/net night)	Trap-net CPE (#/net night)	Fyke-net CPE (#/net night)
Gun Lake	**Barry, Allegan**	**Apr-2015**	**2,680**	**17.8**	**2.0**	**2.0**	**2.6**	**1.2**
Houghton Lake	Roscommon	Apr 2001 - Mar 2002	20,075	24.9	6.9	6.7	2.9	1.4
Michigamme Reservoir	Iron	May 2001 - Feb 2002	6,400	14.6		3.7		6
Crooked-Pickerel Lakes	Emmet	Apr 2001 - Mar 2002	3,434	16.3	11.7	3.4	2.5	2.3
Burt Lake	Cheboygan	Apr 2001 - Mar 2002	17,120	7.8	5.6	2.5	0.4	0.1
Muskegon River	Muskegon	Apr 2002 - Mar 2003	4,232	42.6	0.5	0.5		
Lake Leelanau	Leelanau	Apr 2002 - Mar 2003	8,320	13.5	15.1a	27.9a	3.1	0.5
Cisco Lake Chain	Vilas	May 2002 - Feb 2003	3,987	45.2		11.4		5
South Manistique Lake	Mackinac	May 2003 - Mar 2004	4,133	34.5	44.5	11.5	2.3	1
Big Manistique Lake	Luce, Mackinac	May 2003 - Mar 2004	10,346	8.5	39.9	9.2	1.1	1.1
North Manistique Lake	Luce	May 2003 - Mar 2004	1,709	6.2	6.7	4.2	0.6	0
Bond Falls Flowage	Ontonagon	May 2003 - Oct 2003	2,127	10.0		15.9		3.9
Grand Lake	Presque Isle	Apr 2004 - Mar 2005	5,822	5.7	11.2	4.7	1.1	0.2
Long Lake	Presque Isle	Apr 2004 - Mar 2005	5,342	6.5	1.9	1	0.8	0.7
Peavy Pond	Iron	May 2004 - Feb 2005	2,794	9.5		0.9		6.3
Black Lake	Presque Isle	Apr 2005 - Mar 2006	10,113	5.9	2.6	1	3.5	1.6
Lake Gogebic	Ontonagon	Apr 2005 - Mar 2006	13,127	8.9		38.8		2.7
Lake Michigamme	Baraga, Marquette	May 2006 - Sept 2006	4,292	6.2		1.3		1.8
Lake Charlevoix	Charlevoix	Apr 2006 - Mar 2007	17,268	3.3	6.5	1.6	2.5	0.2
Portage-Torch Lakes	Houghton	Apr 2007 - Feb 2008	13,208	3.2	26.6	8.9	5.4	3.6
Elk-Skegemog Lakes	Ant., Kalk., Gr. Traverse	Apr 2008 - Mar 2009	10,961	4.9	0.4	<0.1	1.6	0.4
Mullett Lake	Cheboygan	Apr 2009 - Mar 2010	16,704	4.3	1.9		3.2	
Indian Lake	Schoolcraft	Apr 2010 - Mar 2011	8,647	2.4	18.0	16.3	1.2	0
MEAN			8,644	13.0	11.8	7.8	2.1	1.9
MEDIAN			7,360	8.2	6.7	4.0	2.3	1.3

a = South Lake Leelanau only

Table 7. Mean length (inches) for each age class of fish captured during the 2015 surveys on Gun Lake. Data from Black Crappie, Northern Pike, and Walleye are from April surveys whereas the data for other species are from May surveys.

Species	Age													Growth Index
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII+	
Black Crappie		6.1	8.3	10.1	11.0	11.3	12.2	12.5	13.1	13.0	13.4	13.7	13.7	1
Bluegill	2.0	3.5	4.7	5.4	6.5	6.8	7.9	8.1		9.2				-0.2
Largemouth Bass	3.8	7.1	10.0	11.9	12.7	12.2	13.8	15.5	12.6	18.0	19.5			0
Northern Pike	12.9	17.7	20.9	23.0	24.2	27.8	28.6	29.6						-0.3
Pumpkinseed		3.5	5.1	6.6	7.1	8.1	8.4							1.1
Smallmouth Bass	3.2		10.7							15.6				
Walleye	9.7	13.0	15.2	18.7	20.5		23.1		20.2				22.7	1.5
Yellow Perch	3.3	4.2	5.4	6.3	7.8									-1.1

Table 8. Growth index, CPE, Bluegill indices score and ranking (Schneider 1990) for fyke net, trap net, and electrofishing surveys completed on Gun Lake during 1966 – 2015.

Date	Growth Index	EF		FYKE/TRAP		Rank
		CPE	Score	CPE	Score	
04/12/1966		10.8	6.8			Excellent
06/13/1983	-0.2	61.1	2.6	22.8	3.0	Acceptable
04/26/1989	1.1	37.3	4.4	10.3	5.4	Good
05/03/1999	-0.1			18.4	4.2	Satisfactory
05/13/2015	-0.2	155.0	3.0	23.9	2.6	Acceptable

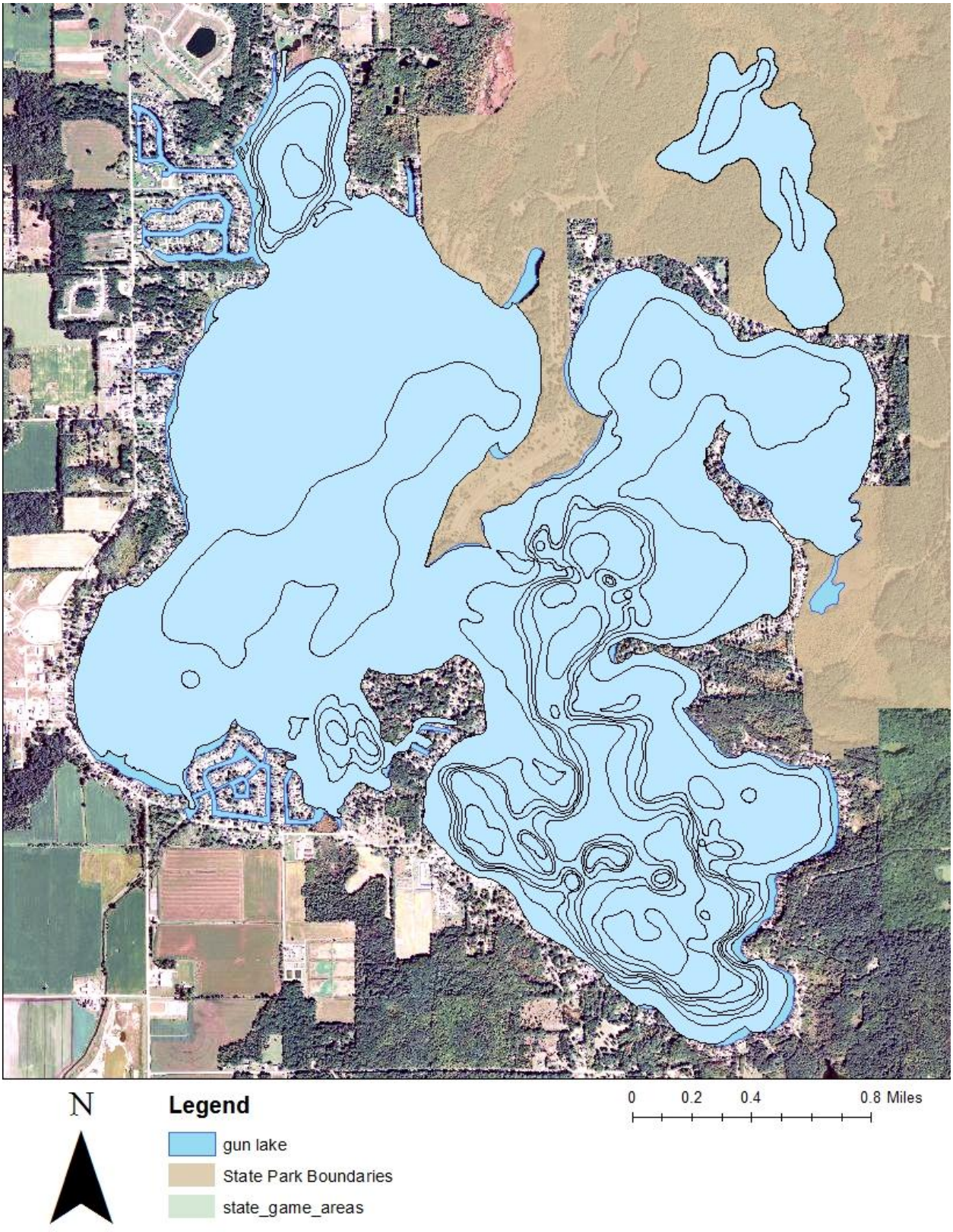


Figure 1. Map of Gun Lake located in Allegan and Barry Counties, Michigan.

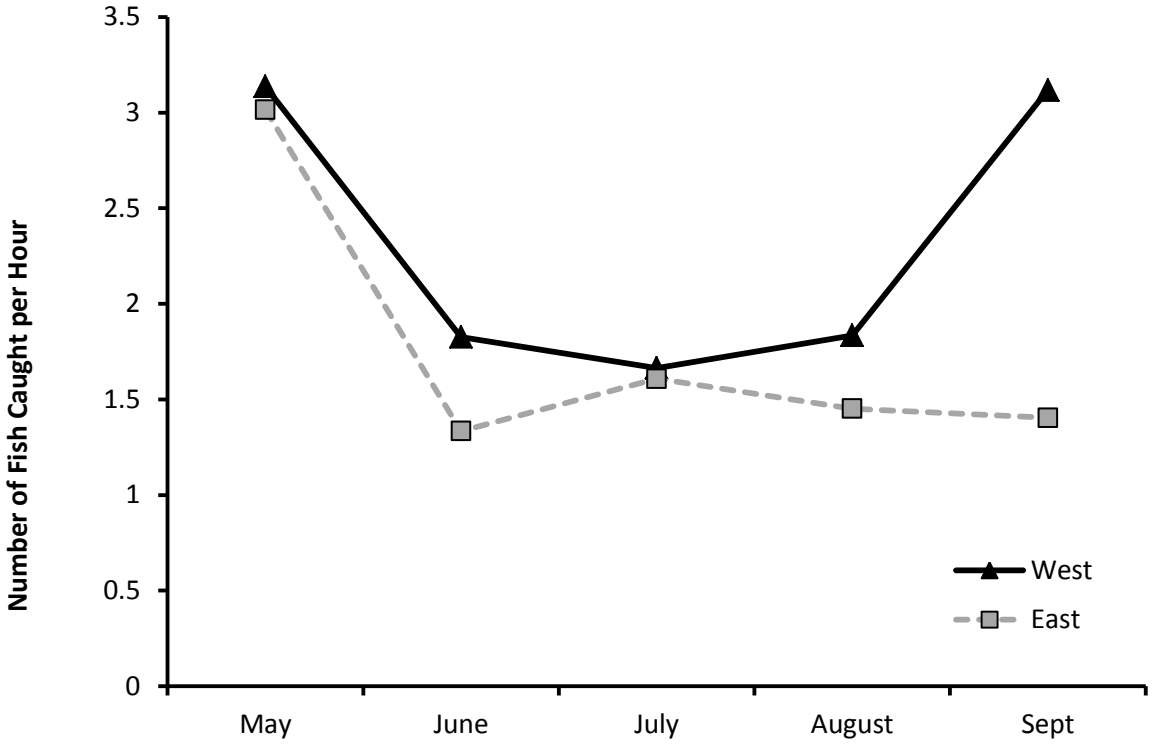
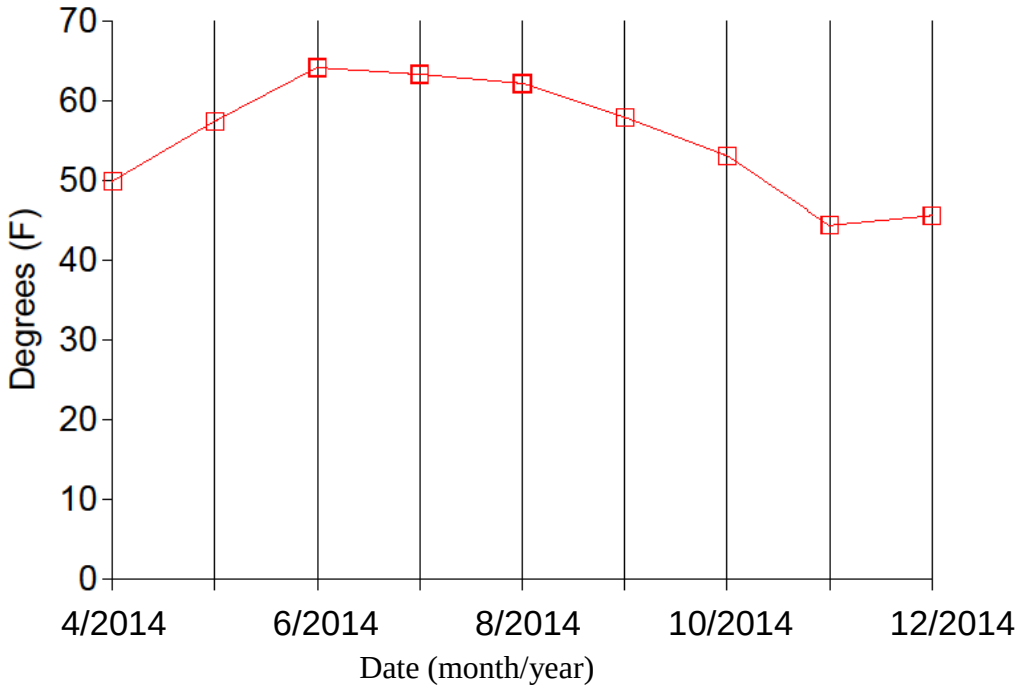


Figure 2. Total number of fish caught in each lake basin during the 2014 Gun Lake creel survey.

A.



B.

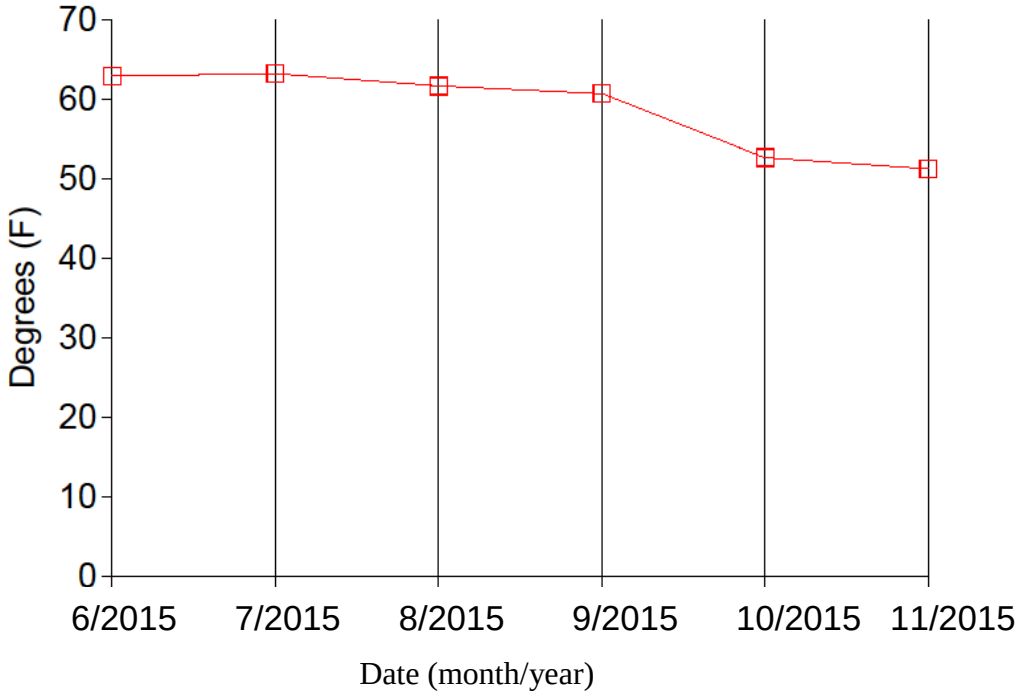


Figure 3. Mean monthly water temperature from temperature loggers deployed in Gun Lake at a depth of 2.5 feet in 2014 (A.) and 2015 (B.).

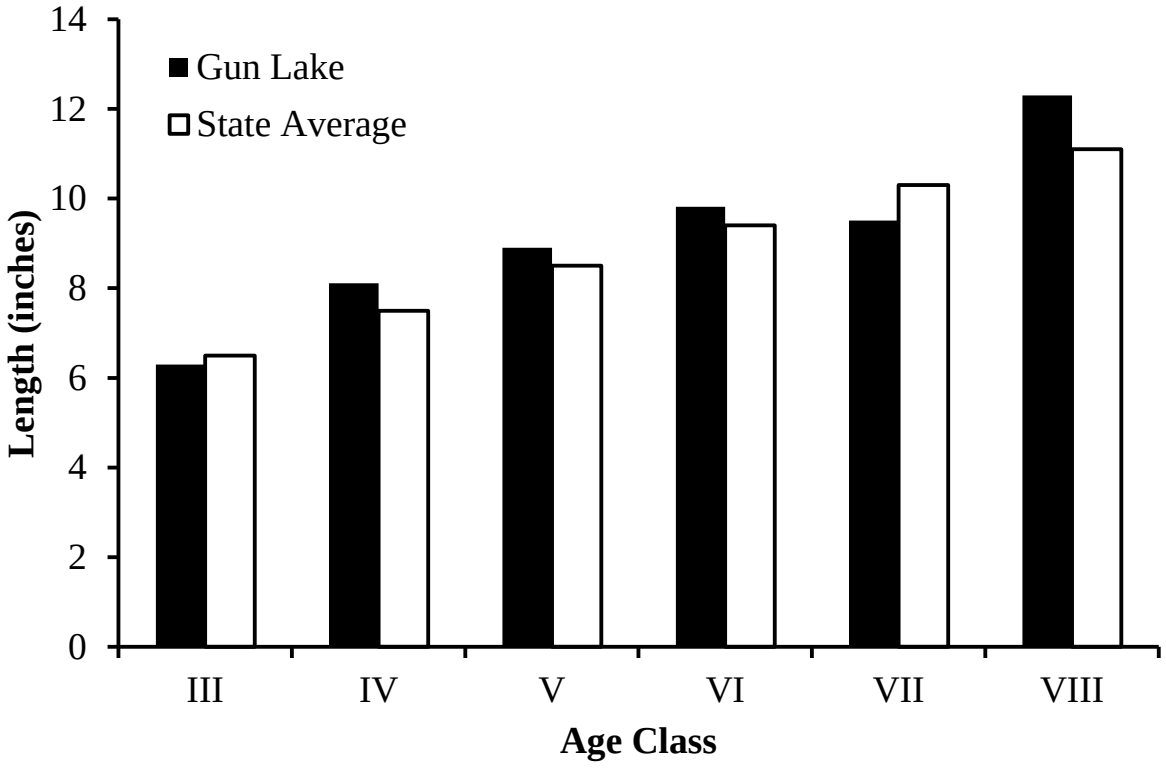


Figure 4. Mean lengths at age for Yellow Perch collected in Gun Lake in April 2015 compared to statewide average lengths (Schneider et al 2000b).

Figure 5. Mean lengths at age for Bluegill collected in Gun Lake in May 2015 compared to statewide average lengths (Schneider et al 2000b).

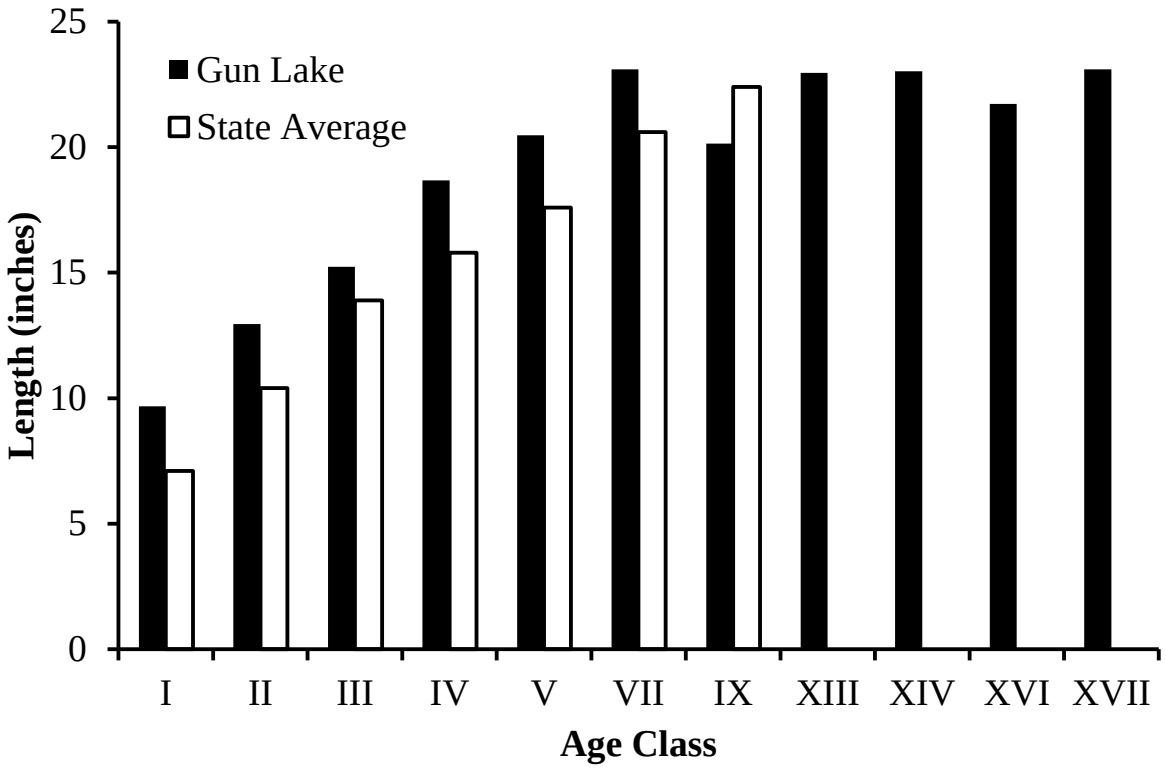


Figure 5. Mean lengths at age for Walleye collected in Gun Lake in April 2015 compared to statewide average lengths (Schneider et al 2000b).

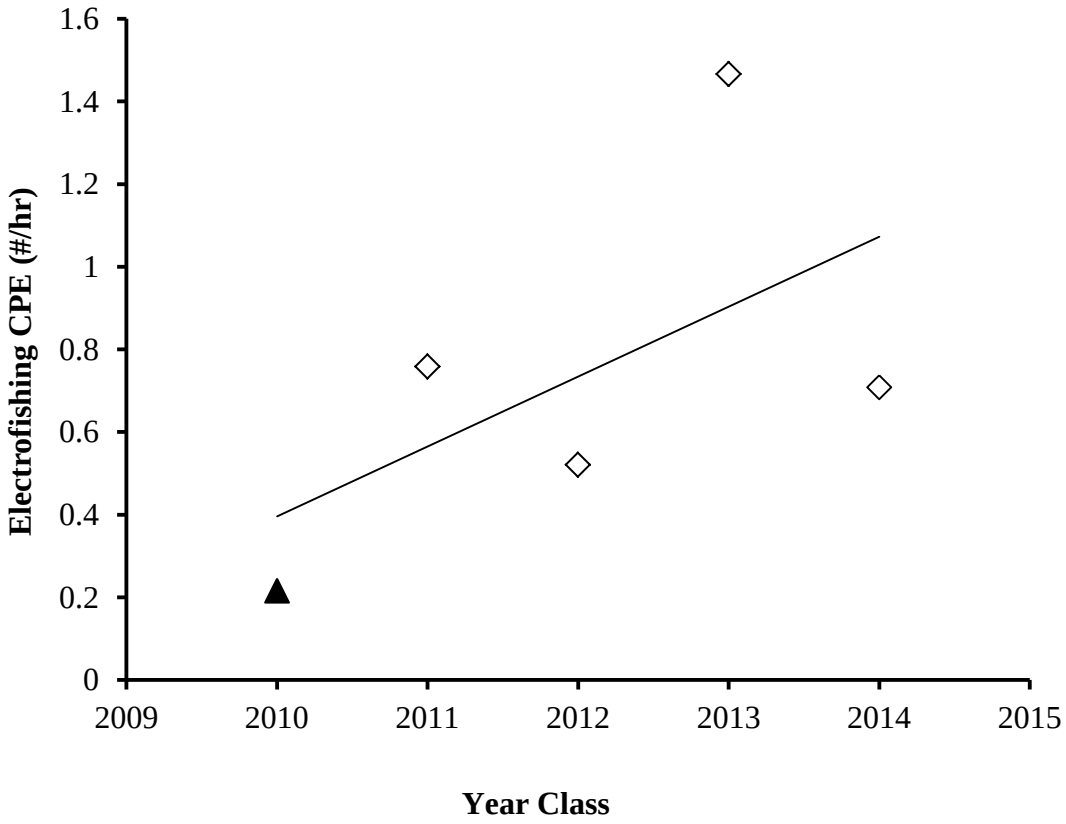


Figure 6. Mean electrofishing catch-per-effort (CPE) of Walleye year classes during the 2013 and 2015 surveys on Gun Lake. Black triangles represent years where fall fingerling Walleye were planted and white diamonds represent years where both spring and fall fingerlings were planted.

Figure 7. Mean length at age for Northern Pike collected in Gun Lake in April and May 2015 compared to statewide average lengths (Schneider et al 2000b).

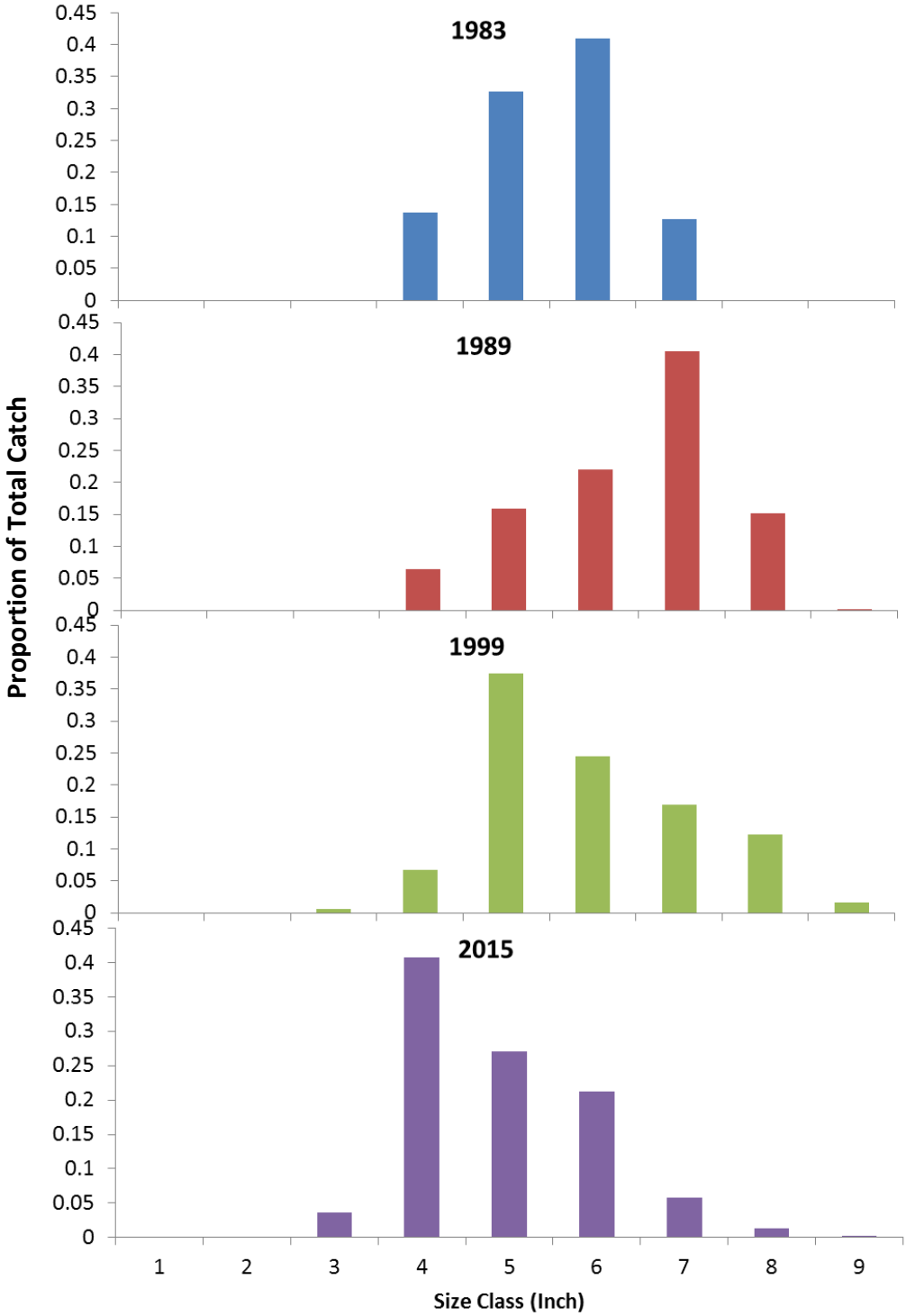


Figure 8. Length frequency for Bluegill captured in surveys using fyke nets during 1983 to 2015.